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An Innovation and Risk Dashboard

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Completed Research

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Abstract

In order to manage new product and service innovations within organisations effectively, cognizance needs to be taken of a wide number of diverse risks that are multidisciplinary in nature. However, to display such a large number of risks in a fast-changing environment on short notice with dispersed information requires novel techniques. Using a design science methodology, a unique artefact was delivered with a design grounded in scientific literature, including prescriptive and concrete knowledge sources as well practical knowledge. This risk and innovation dashboard allows new product and service development teams to make quicker and more informed decisions during stage/gate processes. Since no dashboard design approach for managing risks in new product and service development could be found in the academic literature, this paper hopes to make a novel contribution to the state of the art in the fields of decision support systems as well as innovation and risk management.

Keywords: Design Science, Innovation, Risk Management, Decision Support, Dashboard.

1 Introduction

The continued sustainability of an organisation is increasingly dependent on successful innovation (Cooper, 2001). Innovation accounts for between 33% and 60% of organisational revenues (Nambisan, 2003). Despite considerable investments, consumer innovations are subject to an 80% failure rate even before launch (Park and Kim, 2011).

Considerable uncertainty exists during the New Product and Service Development (NPSD) lifecycle, such as an increasingly complex technical, economic and social environment (Williams, 1995). NPSD teams are increasingly driven by a 'faster-better-cheaper' philosophy, yet pressurised to provide innovative solutions (Cooper, 2003). More innovative projects are subject to greater degrees of risk (Kessler and Chakrabarti, 1999). Furthermore, high technology based service innovations are inherently complex due to a multitude of cross-functional resources, vendors, stakeholders, customers and new business models that distribute risk over a wide area of the organisation (Olsen et al. 1995). Technology risks were indicated as being the source of cost escalations of 45% and schedule overruns of up to 22 months (Olechowski et al. 2012).

While the study of innovation has become increasingly popular, there is a lack of comprehensive frameworks for managing risks in innovation (Yen et al. 2012). To address this research gap, the Action Research (AR) study developed an integrated innovation and risk management framework (IRMF) and supporting risk artefacts to more effectively manage risks via three iterative cycles studied over five years in a large multinational telecommunication company. During the action research iteration, the NPSD group requested a summarised executive overview to be presented during NPSD stage/gate meetings. Risk reviews were often quite lengthy and top management was not inclined to work through volumes of data. A snapshot of top risks should be submitted as a concise, single-screen, decision-making tool to assess whether the proposed product and/or services (P&S) can proceed to the next stage/gate. The objectives were to facilitate proactive risk communication and to allow identification of major risks at a glance, as well as to be easy to understand, use and automate. Additionally, the dashboard should promote and reflect the research objectives and interventions introduced during the AR iterations.

The design of a dashboard presented several challenges. Deliberations and interpretations of the problem are largely dependent on information from disparate functional areas of the NPSD group. Furthermore, the users who attended the stage/gate meetings were unpredictable. Information was difficult to obtain and was stored in several documents and emails; and it was not always clear what the latest version or status was. Information was often of a 'tacit' nature, contained expert knowledge and was difficult to present. The key IT requirements were to accommodate a complex and evolving knowledge basis and unstructured supporting processes and frequent last-minute changes. Additionally, the dashboard should be adaptable to the context of the organisation as well as the unique requirements of the P&S. Due to the sheer number of risks presented during P&S development, it was necessary to develop a suitable abstraction layer that could extract and present Key Risk Indicators (KRIs) from the risk knowledge base. The main challenge to developing the dashboards was conceptual, rather than technological (Silveira et al. 2010).

A design science (DS) approach was used to design the risk dashboard. The objective was the development of a risk dashboard as a business management decision-making tool for use at NPSD stage/gate meetings, that provides key risk metrics in a stylish, reliable, usable and customisable interface and improves understanding and subsequent management of risks and Risk Management (RM) processes within NPSD. The dashboard provides a visual decision-making interface that is presented at two stage/gate meetings to allow the P&S to pass through to the next stage gate. The dashboard is built on a RM knowledge base that displays information relevant to the stage/gate and the P&S. Processes to update information from unstructured sources support the dashboard. The dashboard was implemented and evaluated over a period of nine months. Proof of concept was delivered to risk practitioners, and cross-case implementation in two NPSD contexts occurred, complemented with qualitative analysis, application in practice and, lastly, an evaluation by risk experts. The risk dashboard is widely used in the organisation and has expanded to other markets in which the group operates. The dashboard is in the process of being commercialised by a RM system developer.

The main knowledge contribution is the DS artefact itself: the NPSD risk dashboard. While a dashboard is a popular tool in the business environment, scientific literature is lagging. Few academic studies exist and limited guidance is provided (Yigitbasioglu et al. 2012). Dashboard design is still a relatively new area of research (Eppler and Aeschimann, 2009). DS approaches were used to design EIS dashboards (Marx et al. 2011), but to the best of the researchers' knowledge, no dashboards were specially developed for managing risks in NPSD on a per project basis.

The paper starts with a short review of the literature concerning information dashboards, then details the design science approach which was followed and articulates the problem formulation in greater depth. The bulk of the paper is devoted to the design and development of the artefact, followed by a discussion of the implementation. It concludes with a description of the research contributions made by the paper and discusses the limitations and suggests future work in this space.

2 Information Dashboards

The risk dashboard design is novel as it is the first approach that investigates a comprehensive, cross-functional area of risk with a high technology organisation validated over 160 innovation projects. Furthermore, the risk dashboard is adaptable to the unique requirements of the P&S as well as to the NPSD lifecycle requirements. Additionally, the dashboard is built on a substantial knowledge base about risk incidences and opportunities that were developed through four years of AR iterations.

The concept of an information dashboard is not new and was popularised as an Executive Information System (EIS) artefact in the 1980s (Few, 2013), using business intelligence to monitor Key Performance Indicators (KPIs) of organisations such as the Balanced Score Card (Kaplan and Norton, 1992). In NPSD, scoring models are utilised during portfolio management selection to optimise the trade-off between investments and the associated risks, such as the 19-Dimension Scoring Model proposed by Cooper (1999). The use of multi-dimensional measurement models, rather than mere financial models, is more successful at predicting long-term impact of the P&S on the sustainability of the organisation (Meskendahl, 2010). In RM literature, risk dashboards are frequently used to present visual information about Key Risk Indicators (KRIs) (Vinella and Jin, 2005). Risk indicators function as early warning systems, which are often presented via a dashboard interface. However, the risk profile is often difficult to visualise and describe (Horwitz, 2004) which makes it difficult to represent on dashboards. Also, dashboards often fail to communicate the relevant information (Few, 2013).

Since risk reports are often lengthy, the risk profile can be more efficiently communicated by using visualisation techniques, especially if the risks described are complex (Hahn et al. 2007). The benefits of visualisation are seen as facilitating better engagement, quicker learning, improved clarity, and deeper analysis, as well as better retention of information than mere text and print communications (Kontio et al. 2004). Visualisation can, however, present risks such as displaying insufficient and misleading information (Bresciani and Eppler, 2008).

While business interest in dashboards as a management tool is growing, the scientific literature is lacking; only a handful of academic studies exist which provide limited guidance to practitioners and researchers (Yigitbasioglu et al. 2012). The design of a dashboard can, therefore, still be considered a relatively recent area of research (Eppler and Aeschimann, 2009). While some researchers use DS approaches to design EIS dashboards, no risk dashboards could be found specifically developed for use in NPSD (Marx et al. 2011). Since no dashboards were specially developed for managing risks in NPSD on a per project basis, related studies were investigated.

Marx et al. (2011) provided six principles for designing EIS prototypes, which include a comprehensive information model, reduced information, interface design, flexibility, information management principles and prototyping. Silveira et al. (2010) developed a risk dashboard that specifically deals with compliance on an organisation-wide basis but does not use DS approaches. Eppler and Aeschimann (2009) developed a systematic framework for risk visualizing in RM which answers question of why, what, for whom, when and how as well as which kinds of risks and risk related information (what) should be visualized. Guidelines for the development of dashboards based on principles in Gestalt theory were investigated to establish how to arrange data in sensible ways while conveying meaning to the intended audience (Few, 2013).

However, the research problem did not follow structured decision-making processes that can be effectively supported by familiar classes of systems like EIS. NPSD processes are characterized as 'emergent processes' where problem solving, assessment and action taking do not follow a predictable pattern (Markus et al. 2002). The problem was essentially characterised by Markus et al.'s (2002) design theory for systems that support emergent knowledge processes (EKPs) as 'organisational activity patterns' that display "an emergent process of deliberations with no best structure or sequence; requirements for knowledge that are complex (both general and situational), distributed across people, and evolving dynamically; and an actor set that is unpredictable in terms of job roles or prior knowledge". The EKP system design and development principles were used during the development of the risk dashboard.

3 Research Approach

Simon (1996) coined the phrase 'science of the artificial' to describe knowledge gained by DS as "a body of intellectually tough, analytic, partly formalisable, partly empirical, teachable doctrine about the design process" (Cross, 2001, p. 1). The researchers developed a combined approach based on the Peffers et al. (2006; 2007) and Sein et al. (2011) Action Design Research (ADR) frameworks. The DS framework has been adapted to follow the requirements of the organisation and the type of artefact to be introduced. Figure 1 below provides a consolidated view of the DS method developed by the study. Deliverables for each phase are shown and the arrows from the Formalisation of Learning Phase designate that all the previous deliverables need to be evaluated at this point.

Phase 1: Problem Formulation: The research problem is defined according to the context and scope of the organisation and the value of the solution to the key stakeholders. The criteria to measure the effectiveness of the artefact as it is aligned with the objectives were also developed during this phase.

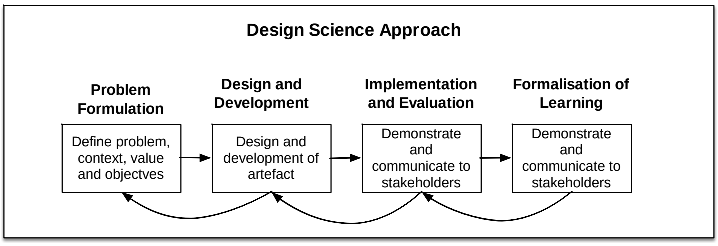

Figure 1: Design Science Approach

Phase 2: Design and Development: This phase is based on Peffers et al. (2006; 2007) 'design and development' stage and the first two parts of Seins et al.'s (2011) BIE phase. It is also important to consider that the design and development follow iterative cycles such as in AR where prototypes are developed and improved.

Phase 3: Implementation and Evaluation: This phase involves the demonstration of the problem within the organisational context and the evaluation of the artefact according to Peffers et al.'s (2006) guideline objectives and benefits. The phase is reflective of the 'evaluation' phase of Seins et al.'s (2011) BIE.

Phase 4: Formalisation of Learning: Seins et al.'s (2011) ADR 'formalisation of learning' principle was selected as the final phase instead of the Peffers et al. (2006) 'communication' phase. The researchers were required to demonstrate generalised outcomes in terms of the problem, solution and the development of new design principles. Since DS was utilised as an alternate approach to AR, a less rigorous communication phase was deemed appropriate. The artefact still, however, needed to conform to properties of being useful and original within the context of where it was delivered. The Hevner, March and Park (2004) guidelines were used to evaluate the validity and robustness of the artefact.

The artefact as a risk dashboard was designed and evaluated using the approaches stated above and was introduced during iteration three of the AR cycle. The design of the dashboard is primarily explorative in nature since research on dashboard design is scarce (Yigitbasioglu and Velcu, 2012).

4 Problem Formulation

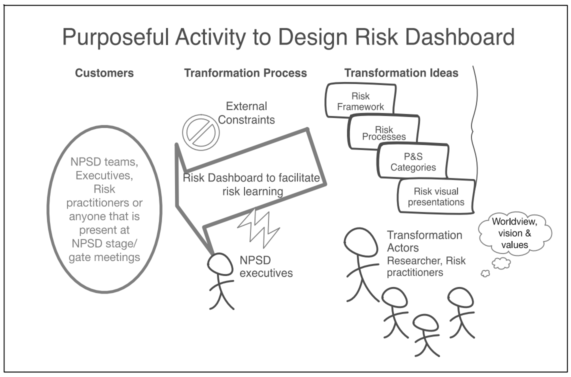

Figure 2: Purposeful Activity

It was first necessary to assess the complexity of the problem. Peffers et al. (2006) argue that working backwards facilitates the solving of unexpected problems, which entail specification of the objective (goal state) to be achieved. Using Soft Systems Methdology (SSM), the root definition (RD) was articulated and purposeful activities were analysed by using the CATWOE mnemonic of SSM. The customers were the NPSD practitioner teams and the risk practitioners who were the ultimate users responsible for compiling and presenting the risk dashboards. The transformation actors were the researchers who designed the intervention that the risk practitioners (as secondary transformation agents) applied to meet the RD objectives. The owners of the process were the NPSD executives who could halt the use of the dashboard and request changes. The transformation ideas were based on the concepts of visualisation as well as the existing IRMF and processes. Several external constraints existed, such as the predictions of who would attend the meetings and how they would deliberate use the risk dashboard. A detailed requirements analysis was not possible, as stage/gate attendees had different risk interests.

More succinct problem identification was initiated by using Eppler and Aeschimann's (2009) systematic framework for risk visualisation. The risk dashboard conformed to the RM framework that was used for NPSD as well as the overall RM framework of the organisation based on the ISO 31000 (2009) framework. Additional requirements emerged as a result of the analysis of the ISO 31000 compliance requirements such as consultation, enabling informed risk-decision-making and fit within the context of the organisation, RM and NPSD and the complete RM process. Presenting all these requirements in a limited space for a sophisticated, high technology, fast-changing P&S was challenging. Silveira et al. (2010) experienced similar difficulties during the design of compliance governance dashboards; they identified these as: (1) identifying the right level of information abstraction; (2) visual presentation of the diverse elements of the risk analysis cycle; and (3) managing various concepts, instruments and data.

Two different dashboards were required at two stage/gates: (1) at the end of the planning stage (Gate 2) and (2) testing phase (Gate 4). More executives would attend the development stage/gate, which therefore required more high-level content. The size of the knowledge gap (meaning the uncertainty aspect of risk) was higher at Gate 2 than Gate 4, since the P&S was already designed and tested during the latter. The closing of the knowledge gap is indicated by the variances between the two dashboards and potentially could demonstrate the value added by RM.

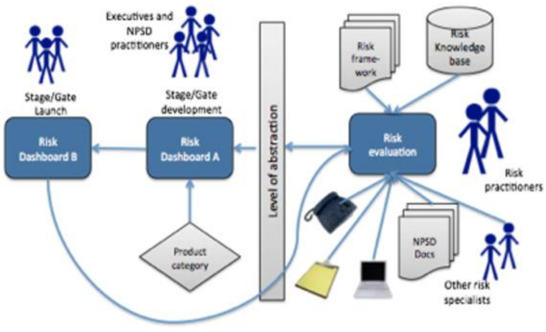

Figure 3: Conceptual Model of Dashboard Design

The risk dashboard was required as a business management tool that could clearly indicate risk statuses by using key project metrics for the primary audience, senior management, to facilitate their functioning in an oversight role within the NPSD organisation. The main risks associated with the P&S should be indicated as well as the required risk strategies as a demonstration of risk versus reward. Additionally, the dashboard should improve risk decision-making and focus on best practices to achieve the key objectives of the P&S. This risk dashboard furthermore was to provide visibility into the RM process and present the users of the dashboard with the ability to understand the key risk metrics.

5 Design and Development

NPSD practitioners were consulted to derive content requirements, but their input was of limited value due to their lack of exposure to risk dashboards. The researchers developed basic prototypes as a baseline from which feedback could be obtained. EKP principles were subsequently used to fill the gaps with regards to what content needed to be displayed. The risk practitioners, as the primary users, were consulted in what Markus et al. (2002) referred to as an 'onion layering' approach. Five layers of 'naïve users' were consulted, which assisted in obtaining their buy-in and commitment. These sessions lead to the development of a conceptual model of the dashboard requirements. A KPI identified by the risk practitioners (aligned to Marx, Mayer and Winter's (2011) principles for EIS development) was the availability of accurate (and latest) information. Further requirements were that Dashboard B (launch stage/gate) could be more operational, whilst Dashboard A needed to be more strategic. Dashboard A should present risks according to a specific P&S portfolio and the impact of those risks should be set out. Such a method was not available, which led to the development of the portfolio classification model. (Davis, 2002).

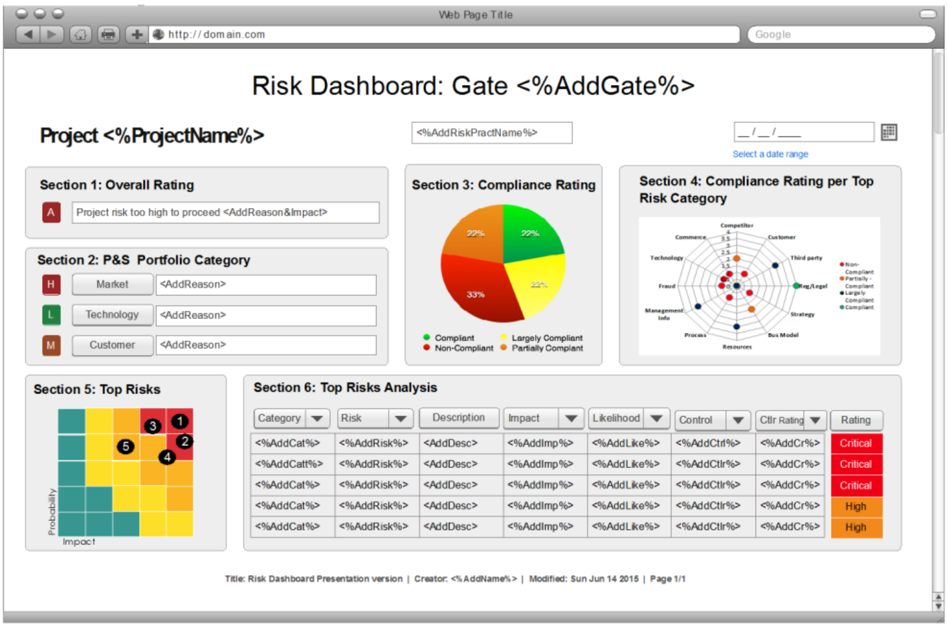

Figure 4: Conceptual presentation of dashboard for development stage/gate

The abstraction layer indicated the process of choosing display data from the available volumes to reduce information overload (Marx et al. 2011). The IRMF featured a large number of risk categories, which could not all be presented. A Risk Breakdown Structure (RBS) determined the top risk categories consolidated and adapted to fit the context of the P&S as well as B2B and B2C contexts. New methods were required to produce additional abstraction layers. Various prototype iterations were tested with different interface designs and alternative risk presentation methods, using different charts and styles of presentation and using information varieties from the knowledge base. During prototyping, the general attitude was that the dashboard appeared appealing and provided a good risk snapshot of the P&S. The abstraction layer rules were to be updated, as they did not achieve the desired level of abstraction. By using risk indicator values (e.g. low, medium, high) and colours (e.g. red, orange, green and blue), more suitable abstraction layers could be designed.

Design for offline action included the design of an effective method of prioritisation activities. The risk methodology already provided an efficient means to prioritise risks by evaluating the impact and probability. Another method used to inspire action was to demonstrate the size of the performance gap related to ambiguity and uncertainty risks. These risks originated from uncompleted activities that could directly influence the success or failure of the P&S. The executives could focus on non-compliant aspects that would impact on the quality of the P&S. Expert and local knowledge was integrated by consolidation of unstructured communications. The objective was to obtain last minute changes to provide an accurate reflection of the project status. Risk practitioners guiding NPSD practitioners through the different information sections of the risk dashboards facilitated practical guidance. Further guidelines such as Gestalt principles were applied. The risk dashboard was automated as far as possible. Last minute information was updated in the knowledge base. All the graphs, heat maps and risk evaluations were automated based on the underlying risk knowledge base. A prototype of the risk dashboard is provided below and the different sections of the dashboard are subsequently explained.

Section 1 – A single qualification of the overall risk exposure of the particular P&S project was developed in collaboration with risk practitioners and senior leadership of RM. The overall rating scheme fulfilled two purposes: to provide (1) a quick guidance to senior leadership of the overall P&S risk, as well as (2) a way for the risk practitioners to reinforce their CEO-granted mandate to prevent P&S from exposing the organisation to excessive risk. The risk rating was classified from A to E, where A meant that the risk was too high for the P&S to proceed, while E indicated the lowest risk level.

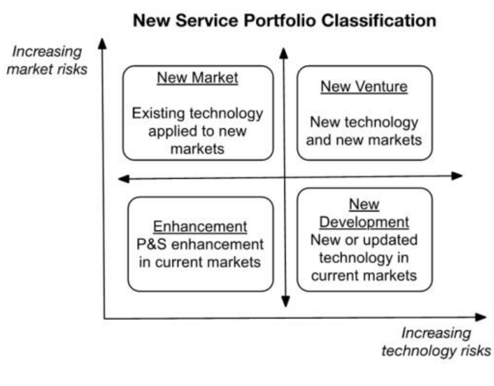

Figure 5: Service Portfolio Classification

Section 2 – Dashboard A required a more strategic focus to advise the NPSD executives of the portfolio risk. No procedure or matrix was in place to aid the classification of P&S into categories. The portfolio classification model was inspired by Davis's (2002) categories of products. However, fundamental changes were required to create categories for services (rather than products). In addition to all other adaptations, a significant departure from the measurement of risk was introduced. Davis (2002) estimated risk according to 'increasing market risk' on the left and, on the right, 'increasing product risk' that was changed to 'increasing technology risk' (refer to Figure 5). It is more relevant to organisations that predominantly launch services to measure the risks according to 'market' and 'technology' risk, especially in B2B, which operates in a highly technical environment. The classification provided in Figure 5 provides a valuable additional abstraction method, allowing focus on either market or technology risks.

Section 3 – The presence or absence of the risk or best practice was indicated in this section according to a unique compliance rating designed for each risk category of the IRMF. Four possible compliance levels exist on a maturity scale that aligns to capability maturity models (CMM) developed for the IRMF. These are evaluated according to evidence presented by the NPSD teams: Level 4: Compliant (C); Level 3: Largely Compliant (LC); Level 2: Partially Compliant (PC); and Level 1: Non-Compliant (NC). If a particular risk was rated at Level 1 NC or Level 2 PC, it was specified as a mandatory requirement. A Level 3 LC rating required suggestions for improvement and Level 4 C rating indicated conformance to best practices. The compliance ratings offer a summary of the total percentage of uncompleted activities and knowledge gap risks that exist due to ambiguity and uncertainty within each of the 24 categories of the IRMF.

Section 4 – The radar chart indicates the knowledge gap and makes visible the top categories of non-compliance. A RBS was used to develop the abstraction layer modified according to the portfolio classification. For a P&S that is classified as 'new market', the market-related risk categories will be more important since the technology is known and uncertainties and opportunities exist within the market. Where technology risk is higher, such as in the 'new development' category, the technology risks would be more important.

Section 5 – The 5x5 risk heat map provides a visual presentation of the top individual risks (shown in Section 6) along with a qualitative scale of probability and impact.

Section 6 – The principal risks associated with the P&S are aligned with the ISO 31000 (2009) framework that allows for the display of residual risks. Residual risks consider the extent to which risks are mitigated by risk controls. The risks are considered in terms of impact that is multiplied by probability on a 5-point scale. The effectiveness of the control is deducted, and this provides an indication of the residual risks. The risks and controls are based on the risk lists and risk strategies developed during the AR iteration and contained within the risk knowledge base.

6 Implementation and Evaluation

The implementation process was inspired by Markus et al.'s (2002) EKP principle of design for customer engagement by consulting with the individual risk practitioners to obtain buy-in and collaborate on the development of the dashboard. The personal approach, rather than a group approach, worked well. By the time the dashboard was introduced in a group setting, the risk practitioners had bought into the concept. RM measures were adequately organized into groups of related information, and colour was effectively used to highlight areas where attention was required. The visual design was thought to be pleasing. Risk practitioners, however, had reservations around whether the NPSD practitioners would approve of the dashboards since the dashboard style did not align with the prevailing predominantly text-based NPSD dashboards. Executive approval was initially tested when the dashboard was presented to the executive in charge of RM in a group setting. The opinion was that the executive approved of the dashboard but lacked an intuitive understanding of it. It followed that the dashboard was required to be demonstrated with some training to the NPSD teams. Two basic evaluation approaches are used by studies, namely user studies and expert evaluation (Gannholm, 2013).

Dashboards were subsequently demonstrated and explained to NPSD teams during special focus sessions. Two sessions with respondents from B2B and three with B2C respondents took place. All prospective dashboard users were present, and attendees ranged from eight to 12 at a time. The objective was to determine the usability of the dashboard. Following a walkthrough by a risk expert explaining the different components, questions were posed: (1) what they thought about the dashboard; (2) if they believed that it was useful; (3) if the information was relevant; (4) whether there was missing information (anything else they wanted to look at); (5) whether there was too much information; (6) whether it was easily understandable; (7) whether it was unnecessarily complex; and (8) what they thought about the presentation of the information regarding layout and symbols/icons. NPSD group consensus was that the dashboard was useful, relevant, not too complicated and understandable, and the attendees liked the way it was presented. NPSD practitioners remarked, 'that it was definitely useful' and even though they did not have previous exposure to a risk dashboard, they 'thought it was good'. Additional comments were that the dashboard was 'very colourful', 'looks very professional' and 'delivered what was asked'.

B2B executives generally indicated a more favourable disposition to the dashboard than the B2C teams. Top management was attracted to the 'look and feel' of the risk dashboards. The strong selling point was a quick summary and overview of risks instead of detailed documentation that supported the risk assessment of the P&S. The NPSD practitioners mentioned that the dashboard delivered on their purpose of providing an accurate bird's-eye view of the risks, relevant to the specific P&S, as well as the stage/gate meeting. A further test came when the dashboard was implemented and demonstrated at a stage/gate meeting where high-level executives were present that were not previously exposed to the risk dashboard. One of the researchers was meant to introduce the dashboard, but instead, the product manager talked the executives through the dashboard with a complete understanding of what each of the elements meant. One of the senior executives expressed unexpected delight by remarking how much he liked the risk dashboard. The risk dashboard was subsequently implemented at various stage/gate meetings and integrated as a key deliverable of the stage/gate processes. An unintended consequence of the risk dashboard was that other risk specialist units felt pressurised to deliver similar dashboards, stating that they needed to compete to provide 'fancy dashboards like risk'.

Five months after the dashboard was implemented, risk practitioners convened to conduct a final evaluation of the dashboard. Alignment to its stated objectives was confirmed. An assessment of compliance to Pauwels et al.'s (2009) metrics for adoption and success of marketing dashboards was conducted by the risk experts. The results indicated that all relevant users were consulted, the decision-making style of the organisation was considered, and interdepartmental coordination was included, as were key industry metrics. The fit between the metrics, sophistication, visual display and drill-down capabilities with the user needs were considered. Implementation considered key success factors such as support of top management, user involvement, prototyping, communication, training and IT department involvement. A positive predisposition was indicated in terms of attitude, trust and delivering on expectations. These criteria can be effectively applied for the development of NPSD risk dashboards.

For DS design it is of particular relevance to demonstrate the utility of the dashboard. Usefulness was evaluated by practitioners and experts and then in a practical organisational setting for a period of five months applied to more than 50 diverse NPSD projects. The dashboard was effective in supporting the real-life problem situation of functioning as a business management decision-making tool during stage/gate meetings. The key risk metrics that indicated effective management of risks and opportunities associated with innovation were utilised on a per project basis and improved understanding and subsequent management of risks and RM processes within NPSD, established by the increased utilisation of the dashboard in other project contexts and countries. The dashboard evolved as an essential tool supporting innovation project stage/gate decision-making in the organisation. The dashboard utility rested in its ability to help practitioners solve a practical problem as well as providing a process that guides informed risk aware decision-making and problem solving.

The success of the dashboard was assigned to the provision of consolidated risk information at the stage/gate meetings, which facilitated an improved understanding of the risk processes. Acceptance of the dashboard was also attributed to the organisational culture, since NPSD practitioners could establish that the dashboard was designed based on robust processes and research, as they would typically suggest changes. Risk practitioners perceived the fundamental advantage of the risk dashboard to be the process implemented to obtain the latest information from NPSD project stakeholders. NPSD practitioners were not exposed to surprises due to having full knowledge of what would be presented by risk practitioners at the stage/gate meetings. Formerly, stage/gate meetings could be contentious, as some P&S would not pass through to the next gate due to risks that were highlighted which reflected negatively on the responsible NPSD practitioner. The dashboard was reckoned as a tool for building trust and consensus during the stage/gate meetings rather than as merely an information device. The tool changed behaviour in the organisation where risks and opportunities were assessed via calculated decision-making methods.

7 Research Contributions

This study applied DS to develop an organisation artefact within the main study method of AR. The knowledge contribution (DS phase 4) is articulated by reflecting Gregor et al.'s (2013) DS knowledge framework by explaining the knowledge contributions in terms of descriptive knowledge (what?) and prescriptive knowledge (how?). The section is concluded with a practical summary of generic guidelines for the development of risk NPSD dashboards. Prescriptive knowledge sources (how?) are subsequently explained as knowledge contributions, as indicated in Figure 6.

This study proposes a methodology that can effectively be applied within the context of a large high technology organisation, as well as within an AR study. The methodology consisted of four phases, of which phase two followed an iterative approach. As new requirements became visible, due to the application of additional theories and methods, these were built into the dashboard design. Peffers et al.'s (2007) DS approach and Sein et al.'s (2011) ADR processes offer high-level guidance but do not explain how the actual activities of the processes should take place. This study expands on existing research by providing guidance for problem formulation. Support is provided in terms of structuring the problem to obtain a clear understanding of the context, actors and cultural aspects. Application of SSM RD and CATWOE can aid in understanding the problem and in guiding purposeful action at a high level.

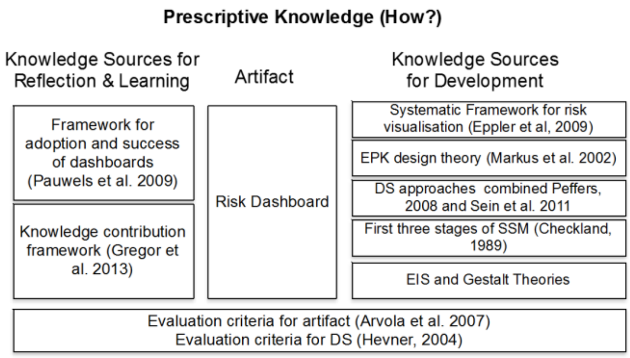

Figure 6: Prescriptive Knowledge

The study further expands on existing DS and ADR research by providing guidance for the design of the risk dashboard. In this study, this was achieved by applying Eppler and Aeschimann's (2009) systematic framework for risk visualisation. The design requirements were further expanded by introducing another layer of design requirements by including compliance to the ISO 31000 framework. It is thus suggested that design should also consider best practices applicable to the development of the artefact. The approach followed by this research implies that, for unstructured problem resolution, the problem should be analysed from several perspectives.

Additional guidance was required to define the content and methods that would be applied to the dashboard. The six principles of Markus et al.'s (2002) EKP theory were applied; these were supportive of the way the NPSD group was structured and indicative of the competitive, fast-changing and unique requirements of each P&S. This study expands on the EKP theory by proposing that additional processes to support near real-time consolidation of information are supported if required. One of the reasons for the success of the dashboard was attributed to inclusion of up-to-date, last minute, unstructured information. Dashboard design principles were applied to analyse how to arrange volumes of disparate data in a sensible way that conveys meaning (Few, 2013).

Hevner et al.'s (2004) evaluation criteria for artefact design are furthermore discussed. The dashboard was practical and was an instantiation of the AR deliverables. Davis (2005, p.18) advises that a DS artefact should have characteristics of a "new or improved design… (that can be) demonstrated by reasoning, proof of concept, proof of value added, or proof of acceptance and use". There were serious initial concerns about the ability to deliver the artefact and about the performance of the artefact. The artefact was applied in a particular domain, namely RM within NPSD, which is deemed to be appropriate for the development of dashboards. All of the challenges inherent in establishing problem relevance were present. People, organisational and technology aspects presented some of these challenges. The problem was relevant to practitioners and the artefact effectively solved the problem.

The research should be of relevance to practitioners as well as researchers. Wilson's (2002) research contributions analysis includes advancement of the theory, methods and applications, improvements to existing works, whether it is interesting and whether it can be transferable to other situations.

The descriptive knowledge (what?) is subsequently discussed with reference to Figure 7. Descriptive knowledge sources included the IRMF as well as the supporting risk artefacts and models developed during the AR. The IRMF consolidated both best practices and risks into the dashboard. The abstraction layer was based on the prioritisation methods developed during the AR iterations, including consolidation of risks into second-level constructs and portfolio classifications. Further contemporary information is being introduced by knowledge about the NPSD lifecycle, stage/gate processes and the different types of knowledge that are utilised at each stage/gate. The ISO 31000 RM process requirements were further introduced during the design of the dashboard. The organisation's NPSD lifecycle and stage/gate processes and the different types of knowledge were utilised at each stage/gate provided descriptive knowledge sources. Other types of 'what' knowledge sources were applied to understand the different categories of P&S. For this purpose, Davis's (2002) model of four major product categories was adapted to more specifically suit services and the requirements of the organisation that predominantly launched services in both B2C and B2B areas. The prototyping followed an iterative process that resulted in the final artefact.

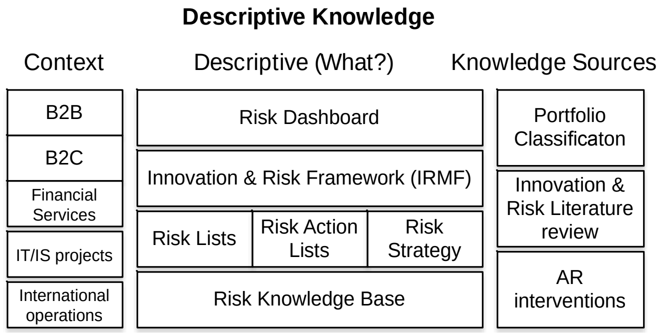

Figure 7: Descriptive Knowledge

The evaluation methods considered usefulness, quality and value of the artefact. Hevner et al. (2004) advised that descriptive evaluation is best suited to original artefacts where no other feasible methods of assessment exist. The dashboard was evaluated in several ways: firstly, by developing proof of concepts to the risk practitioners; secondly, by demonstration in two environments, namely B2B and B2C, during which a qualitative analysis was conducted; thirdly, by putting it in practice for a period of five months, after which it was again evaluated by a panel of risk experts; and lastly, implementing the dashboard in additional contexts which allowed additional cross-case analysis to establish if the dashboard would be applicable to the context of IS projects, mobile-health and the financial and insurance industries in which the organisation operates. At the end of AR iteration three, the dashboard was implemented in other countries in which the organisation operates. The dashboard was also widely tested on over a hundred NPSD projects and could easily accommodate diverse requirements. The adoption and success of the dashboard can be indicated by its increased adoption and use. This research also expands on existing knowledge by the evaluation methods that were applied within the organisation. Qualitative approaches were used which the NPSD practitioners guided by open-ended questions, followed by expert-analysis and usage within a variety of contexts. This multi-disciplinary approach validated the success of the dashboard since usage increased over many different departments and types of P&S.

Generalisable design principles are subsequently articulated. The following lessons learnt could stimulate the design and implementation of a successful NPSD risk dashboard in large organisations in high technology environments. Design principles that can be shared with practitioners are deemed to be: Obtain a clear understanding of the problem by using structured methods; understand the extent of flexibility that is required to address the problem since the application of rigid methodologies to flexible problems is not suitable; use a variety of methods that offer different perspectives to obtain a deeper understanding of the problem; consider best practices suited to the discipline to inform the requirements; and apply a personal one-on-one approach to collaborate with selected experts during the design of prototypes to obtain buy-in and commitment. To elicit requirements, develop prototypes that are diverse and opposing. It is easier to gage negative and positive responses and define requirements from these responses. Consider the decisions and actions that need to be taken by the different customers as a result of the dashboard, as part of requirements. Design the abstraction layer by developing classification models that can reduce the risk indicator values from the risk knowledge base into manageable components. Design supporting processes to obtain the latest, most accurate information for inclusion in the dashboard, as well as rules for maintenance of the dashboards. Use several methods to evaluate the artefact in different contexts to ensure transferability to other environments.

8 Limitations and Future Work

Because the dashboard was specifically developed for the purpose of the organisation, it is not clear to what extent it would be transferable to other organisations. It also depends on the extent to which other organisations actively manage risks in new P&S. The question of transferability between B2B and B2C organisations can be answered as the dashboard was found to be equally applicable to both. In addition, the dashboard and risk processes were introduced in the financial services function of the NPSD organisation, where it was found to be working equally well. The dashboard was also introduced in other countries in which the organisation operates, of which three countries are active users. Considering these contexts, it is viable that the research can be transferable to other ICT contexts.

Limitations of the dashboard could potentially be that the dashboard did not utilise qualitative criteria to gauge the effectiveness of the risk dashboard due to organisational constraints. However the application of multiple evaluation methods and the application of the artefact in different domains should address some of these shortcomings.

Future research should consider how to accommodate unstructured knowledge within a dashboard and introduce flexibility to accommodate unique service requirements. Further methods for abstracting the vast volumes of information and presenting alternative dashboard displays can be considered. How the dashboard contributes toward knowledge management in the organisation has not been formally assessed by this study. We also suggest that less formal but robust validation procedures should be developed to assess the validity of the dashboard within an organisational environment that does not disrupt normal business practices. Such breakthroughs can bring DS design benefits into the mainstream of organisational practice. It follows that practical formal design processes applied within organisational practices will increase innovation, improve quality and drive down cost that will ultimately deliver benefits to consumers.

The artefact was practical, delivered a new design, and proved to be accepted and used within the organisation. The design additionally met criteria of completeness, consistency, accuracy, performance, reliability, usability and fit (Hevner et al. 2004). The design of the artefact delivered contributions in terms of prescriptive and descriptive knowledge (Gregor et al. 2013), was grounded in theory and delivered new knowledge, since no similar NPSD risk dashboards were produced by the literature. Following a formal DS approach for an organisational design was time and resource intensive but the benefits made the effort worthwhile. DS provided useful design perspectives in terms of delivering research-inspired change interventions. The NPSD practitioners were much more risk and best practice aware and adopted a risk-based decision making style during stage/gate meetings. DS can rightfully be credited as a design intervention that can solves problems in novel ways and, as this study has shown, can be effectively applied within a practical organisational context.

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